A Section 508–conformant HTML version of this article is available at https://doi.org/10.1289/EHP11525.

How Improved Is Improved Enough? Gastrointestinal Illness Risk after Sewer Infrastructure Upgrades

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https://doi.org/10.1289/EHP11525

The overall burden of gastrointestinal (GI) illness attributable to combined sewer overflows into the Chattahoochee River in Atlanta, Georgia, was likely lowered by improvements to the system between 2006 and 2008, which resulted in far fewer such events. But when overflows did occur, the average volume of effluent remained unchanged, and large-volume overflows still led to increases in GI illness risk, according to a new study in *Environmental Health Perspectives*.[1]

The findings shed light on a persistent yet largely invisible public health concern in Atlanta and more than 850 other municipalities across the United States with combined sewer systems.[2] No longer permitted in new construction, these systems funnel municipal wastewater and stormwater into the same pipes for combined treatment and discharge. They are prone to overflow, releasing untreated sewage and its load of pathogenic microorganisms directly into the environment. These events are most common during periods of heavy rain, although dry-weather overflows can result when materials such as grease, fallen leaves, or other debris build up in the sewage system.

Federally mandated improvements to Atlanta's aging sewer system were precipitated by a 1995 lawsuit against the city over declining water quality in the Chattahoochee River.[3,4] Improvements included an 8.5-mile-long underground storage tunnel and new pumping and disinfection capacity.[5]

The Chattahoochee River is intimately connected to city life—and potentially exposes residents to harmful bacteria—in more ways than one. Cutting directly through metro Atlanta, "the Hooch" is a popular destination for swimming, boating, fishing, and other recreational uses, with more than 2.8 million visitors annually.[6] Contact with the water can result in accidental ingestion; nationwide, an estimated 90 million cases of GI illness each year are due to water recreation.[7]

The river is also the source of 70% of the region's drinking water.[8] Water is diverted at intakes upstream from the sewage outfalls and thoroughly disinfected at a central plant.[1] Still, it is possible for polluted water to infiltrate distribution pipes headed for homes and businesses, especially during or following periods of heavy rainfall, says Ayse Ercumen, an assistant professor in

The need to understand the dynamics and health impacts of combined sewer overflows becomes more urgent as climate change increases the frequency and intensity of precipitation. Nearly 860 U.S. municipalities use combined storm and sanitary sewer systems.[2] Image: © iStockphoto/400tmax.

the North Carolina State University Department of Forestry and Environmental Resources who was not affiliated with the study.

"The pipes are certainly not sealed from the environment," Ercumen says. "They have cracks and leaks. There are vulnerabilities in the distribution systems, such that if the pipes get submerged in contaminated water, they would be at risk of intrusion of pathogens from the environment."

For the new study, researchers with the University of Washington and Emory University analyzed data from 2002 to 2013 on sewage overflow events, daily precipitation, and visits to local emergency departments (EDs) for GI illness symptoms. Sewer system improvements reduced overflow events from an average 2.31 per week to 0.49 per week. The researchers did not, however, observe similar reductions in ED visits following an overflow, nor in association with rainfall levels.

To gain more insight into relative risk associated with three potential exposure pathways—residential proximity, recreation, and drinking—the authors conducted secondary analyses to discern seasonal, geospatial, and socioeconomic trends. What they found, however, was again somewhat murky. Although seasonality findings were mixed and inconclusive, ED visit risk following an overflow event tended to be stronger in warmer months—perhaps because of an increase in water-based recreation.

The researchers found that high-volume events were associated with an overall average increase of approximately 9% in ED visits over the ensuing 7 days. However, the association was stronger in more affluent areas, even though sewer outflows are primarily located in higher-poverty areas. "This is likely due to the high prevalence of other factors conferring risk of GI illness in these communities," says lead author Alyssa Miller, a PhD student in Environmental and Occupational Health Sciences at the University of Washington. For example, residents in more affluent areas may have more leisure time for recreational use of the river. They also may be more likely to have access to and seek medical care.

The seemingly counterintuitive nature of some of the study's findings is not a surprise, says Andreas Farnleitner, a researcher and professor with Austria's Vienna University of Technology and Karl Landsteiner University of Health Sciences. "Identifying the proportion of GI illness cases attributable to combined sewer overflows is tricky, owing to the highly complex and probabilistic nature of the system, which includes pathogen loads in overflows and environmental waters, exposure pathways, infection susceptibility, and disease reporting," Farnleitner says. The researchers' systematic approach to breaking down this complex question is a strength of the study, he adds.

Shannon McGinnis, an epidemiologist who led a recent study at Temple University evaluating GI illness resulting from recreational exposure to sewer overflow-impacted waters,[9] concludes that overall "the paper highlights combined sewer overflows as a source of enteric pathogens in an urban environment. The authors suggest that recreation may not be the primary route of exposure that explains these relationships. Uncovering other exposure pathways is an important next step."

Nate Seltenrich covers science and the environment from the San Francisco Bay Area. His work on subjects including energy, ecology, and environmental health has appeared in a wide variety of regional, national, and international publications.

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